An Integrated Airborne Architecture for Voice and Datalink CNS Systems

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Presentation outline

- Background - today's CNS systems
- Current trends in CNS system evolution
- An alternative CNS system architecture
  - system overview of synergistic approach
  - features and benefits
- Summary and future work

Today's CNS systems (typical)

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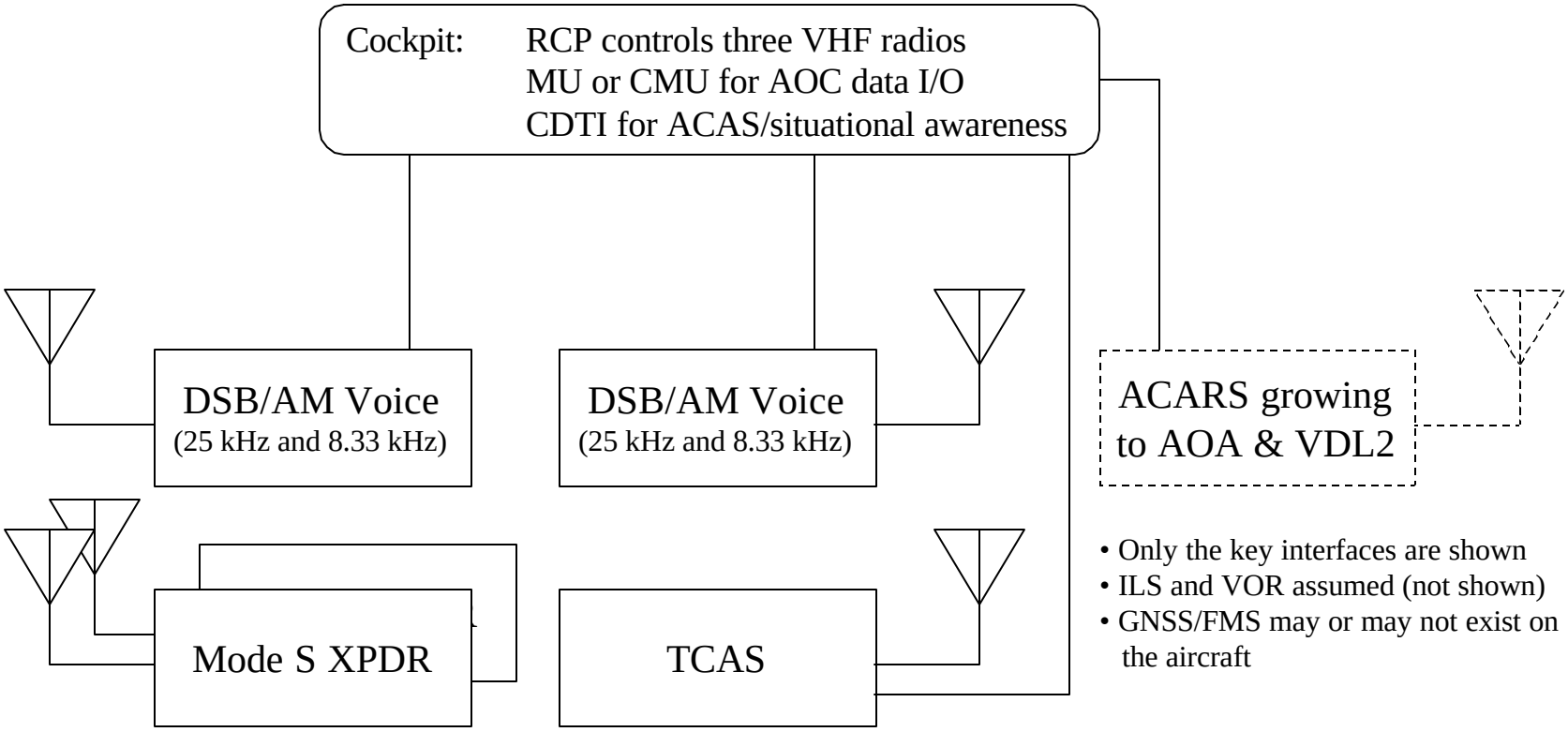

- Subsystems are substantially independent (little or no interaction)
- Significant functional enhancements needed for future evolution

Current trends in CNS system evolution

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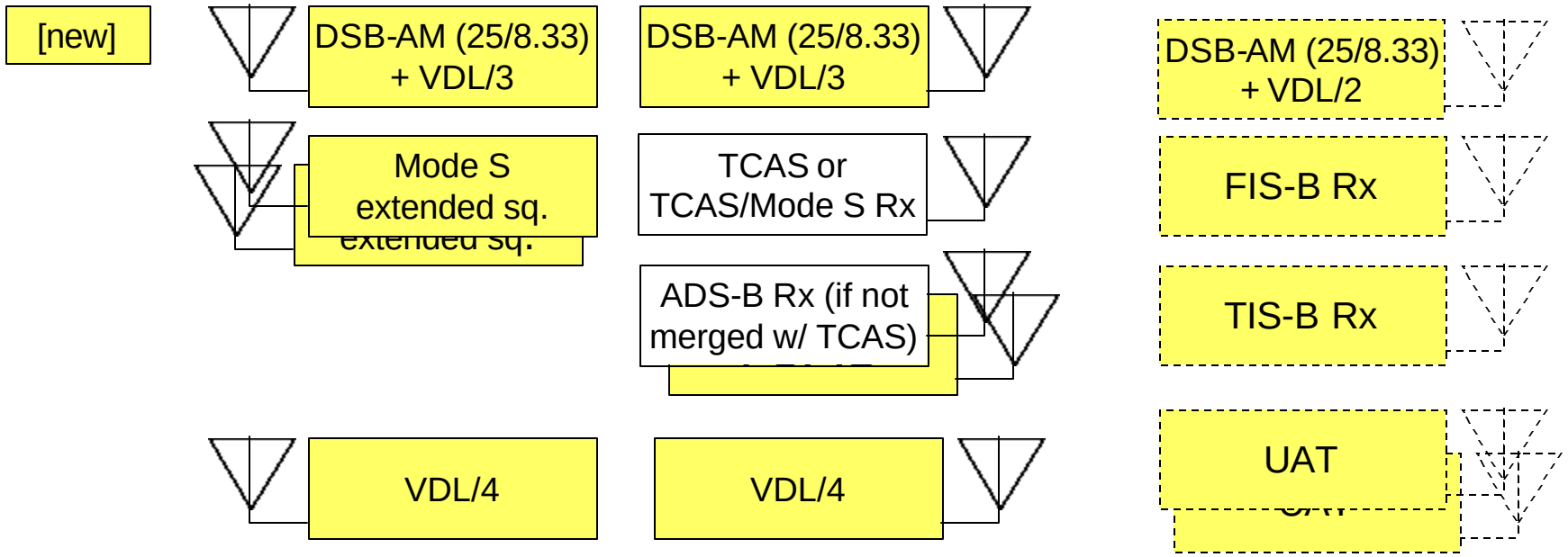

- Subsystems remain substantially independent (little or no interaction)
- Each CNS domain supported by unique hardware and systems
- Large increase in hardware count (LRUs) and antenna count

A synergistic CNS/ATM architecture

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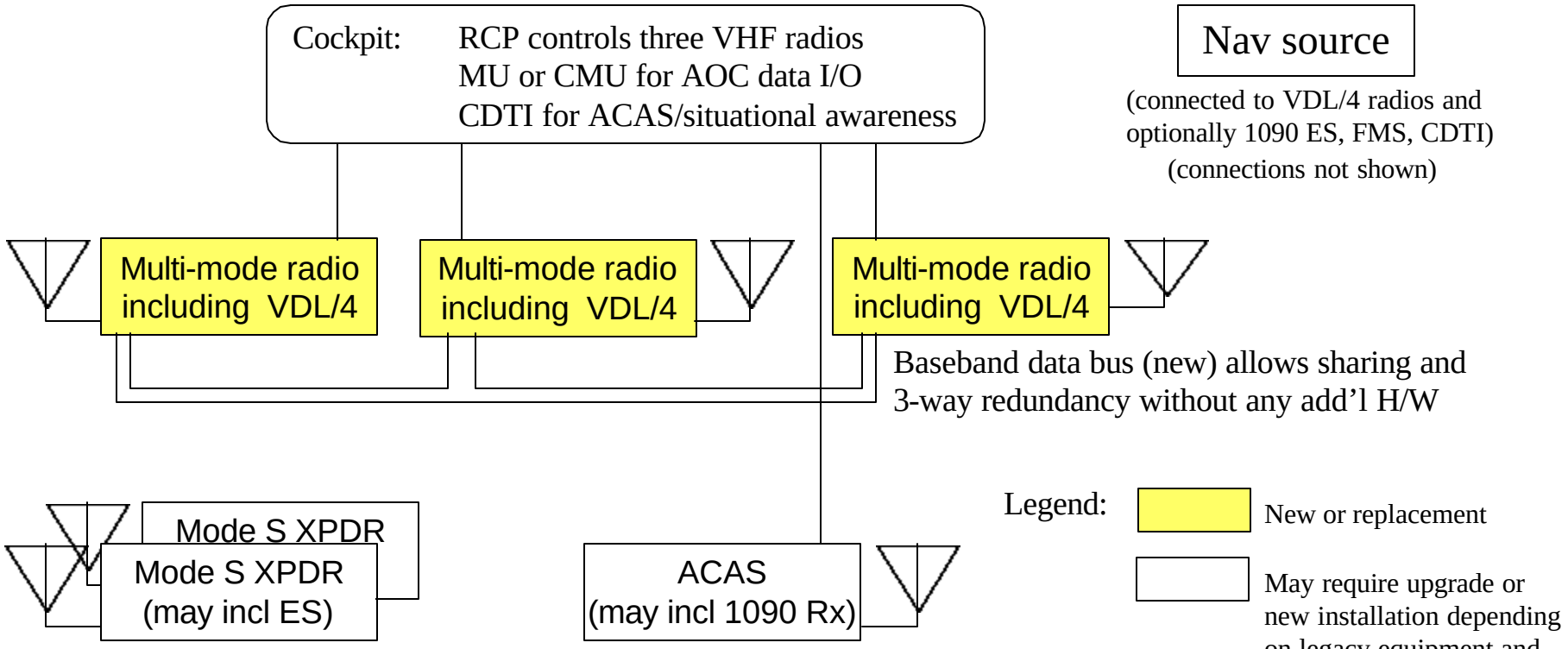
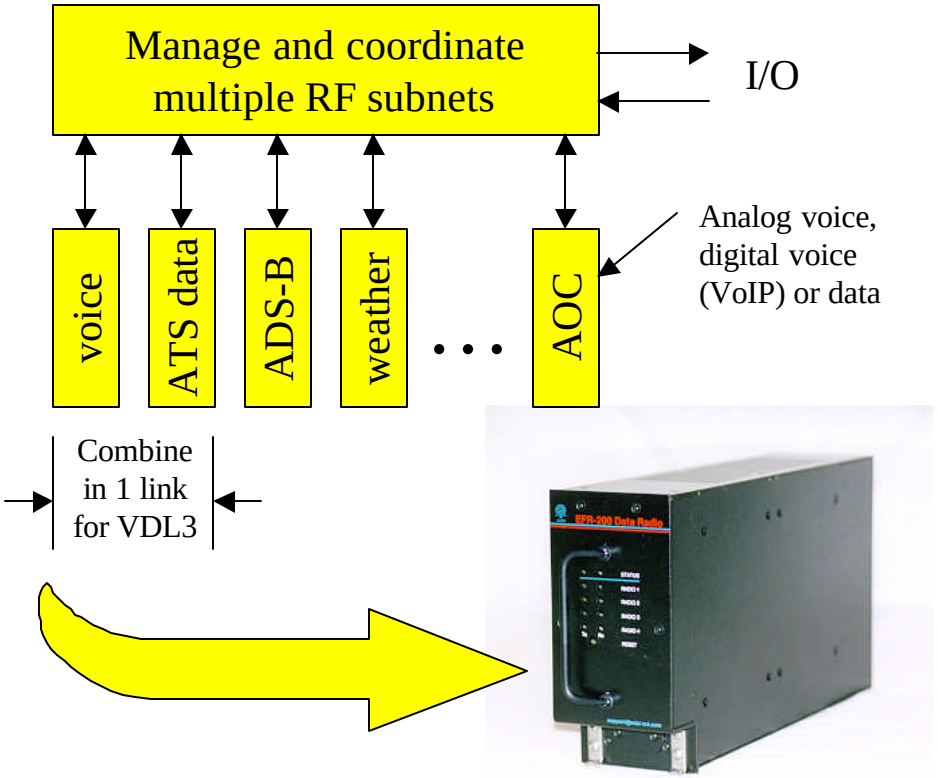


- Multimode VHF radio is the key to increased performance
- CNS domains partially merged in VHF (comm, ADS-B, FIS-B, TIS-B)
- No increase in hardware count (LRUs); no increase in antenna count

Detail on multi-mode radio

- Multi-channel
  - « receives on 4-8 frequencies
  - « transmits on any single freq
- Multi-standard (analog voice, ACARS, VDL/2, VDL/3, VDL/4)
  - « channel cards and HPA can support any standard
- Multi-application (voice, data, ADS-B, FIS-B, TIS-B)
- Connects to a single antenna in its nominal configuration



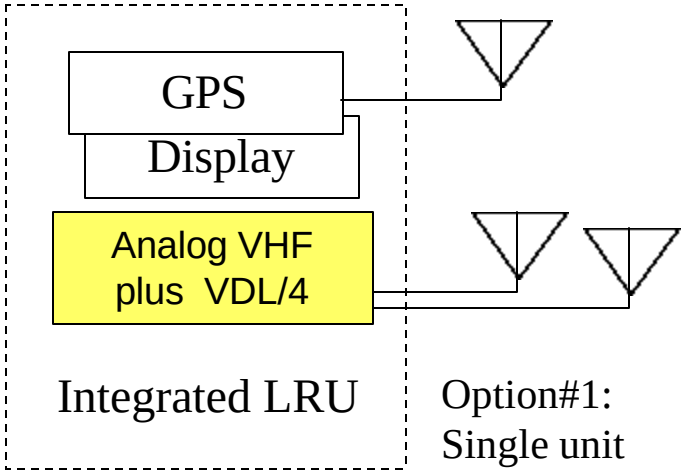
- Baseband data bus to peer LRUs for antenna diversity, data sharing, and increased redundancy. Data bus uses ring architecture for reliability.
  - « Note: total system works as well as traditional stovepipe architecture even if all bus elements fail

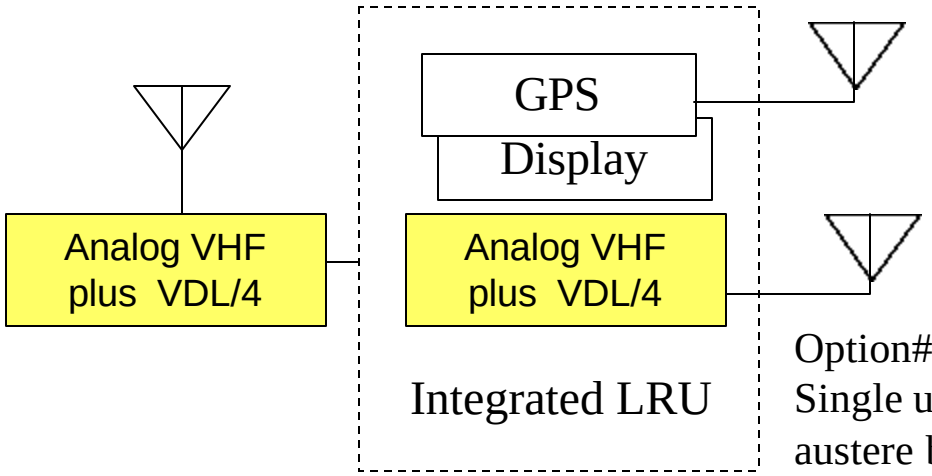
Benefits of integrated architecture

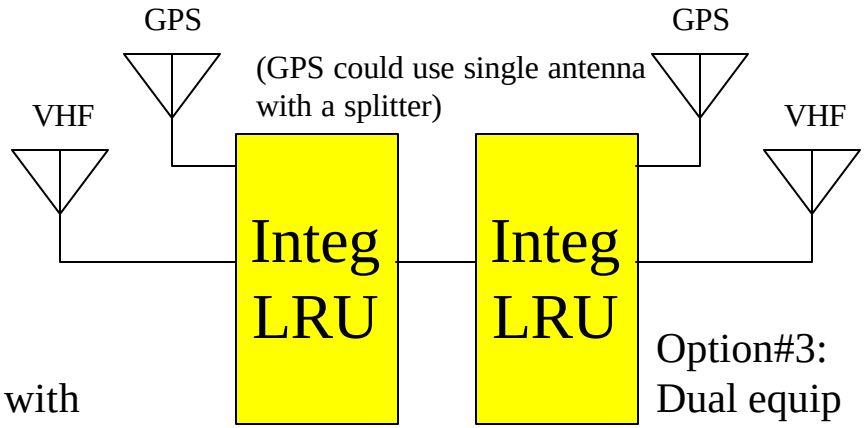
- Improved fault-free performance relative to stovepipe approach
  - « Each ATS and AOC voice and data application has access to three antennas in synergistic CNS/ATM system, vs only one antenna in stovepipe approach
  - « Worst-case (with two LRUs transmitting) is same as stovepipe; most of the time, diversity yields better performance (hence fewer retransmits, better throughput)
- Greater ability and flexibility for failure recovery (automatic reconfiguration).
- Full worldwide interoperability (all existing standards are supported).
- No increase in LRU count; no increase in antenna count. Big cost savings.
- Highly reliable and flexible ADS-B component (uses 1090 ES plus VDL/4)
  - « completely independent systems, multiple LRUs and multiple frequency bands
  - « supports ICAO concept of hybrid ADS-B system architecture
    - 1090 ES dovetails with existing radar and TCAS; offers high update rate at short range
    - VDL/4 offers best long-range and surface performance, addressed air-to-air comm link
    - Functional overlap for many applications, but each link offers unique advantages.

Integrated GPS/COM/EFR (GA)

- Integrated unit (e.g., like Garmin GNC-420) with multi-freq VDL/4 (can include VDL/2 and VDL/3 as optional capability).
- Three variations depending on customer desires.
  - Single integrated unit with 4 VHF channels on each of two antennas (second antenna may be new equipage)
  - Single integrated unit with second multi-mode VHF radio (provides additional reliability of comm and ADS-B due to redundant power supply, VHF power amplifier, etc.)
  - Dual installations with dual displays and GPS
- Other nav (WAAS, VOR, ILS) not shown







Evolutionary flexibility in VHF band

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Integrated voice and data (VDL/3)

- Each LRU contains VDL/3 functionality in firmware
- Nexcom can grow to support data applications (circa 2010), or data can remain on VDL/2 (or VDL/4)

Same hardware supports both alternatives. So risk is minimized and worldwide operations are assured regardless of regional choices.

Analog voice plus VDL/2 and VDL/4

- 8.33 kHz and 25 kHz analog voice
- Digital voice on VDL/4*
  - « up to 3 voice channels per 25 kHz assignment using VDL/3 voice codec
  - « Voice over IP is also an option (COTS codecs & worldwide routing)
- Drop-in replacement for existing voice assignments (CCI = 12 dB)
- Party line plus private line capability (i.e., using VoIP on VDL/4)

*Concept analysis indicates feasibility; development and implementation is an area of future work.

Summary: Synergistic architecture

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- Supports all current and emerging comm and surveillance requirements. Benefits can be achieved on all aircraft types without cockpit mods*
- No increase in LRU count; no increase in antenna count
- Better fault-free performance than stovepipe approach
- Better internal hardware redundancy; more flexibility for automatic reconfiguration in event of failure (internal to each LRU, and across LRUs)
- Simplified logistics and reduced operator inventory (fewer types of boxes)
- No single point of failure. No central controller
- No substantive change to cockpit procedures
- Supports worldwide interoperability. Eliminates regulatory risk.
- Offers evolutionary flexibility in VHF band with no significant cost delta
- Has opportunity for further upgrades and enhancements including ATS data on VDL/4, hybrid ADS-B, & private line voice over IP (VoIP) for AOC

*ADS-B situational awareness requires display that may only exist on newer aircraft (or require costly retrofit). But enhanced communication capabilities and operational flexibility (as well as TIS-B, FIS-B and ADS-B transmit) can be achieved with equipage typical of classic aircraft

Future work

- Spectrum utilization study
  - extend results of NARC, which only looked at two VHF options
  - examine benefits of analog voice combined with VDL/4 for data; also voice over IP on VDL/4
- "System-wide" cost-benefit study that examines all CNS costs to users and service providers, rather than separate study for each CNS domain
  - the system-wide cost is what users and providers actually pay
  - isolated approach tends to obscure cost inefficiencies due to multiple LRUs, antennas, and systems that could possibly be shared in an integrated system
- Support ICAO/AMCP drive to validate VDL/4 for comm applications
  - not required to capture benefits of integrated architecture, but increases evolutionary flexibility and provides alternative to VDL/3 in event that technical, cost or operational problems are discovered with that system.